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Occupational injuries in Canadian youth: an analysis of 22 years of surveillance data collected from the Canadian Hospitals Injury Reporting and Prevention Program

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Abstract

Introduction: Inexperience, inadequate training and differential hazard exposure may contribute to a higher risk of injury in young workers. This study describes features of work-related injuries in young Canadians to identify areas for potential occupational injury prevention strategies.

Methods: We analyzed records for youth aged 10–17 presenting to Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) emergency departments (EDs) from 1991–2012. We classified work-related injuries into job groups corresponding to National Occupational Classification for Statistics 2006 codes and conducted descriptive analyses to assess injury profiles by job group. Age- and sex-adjusted proportionate injury ratios (PIRs) and 95% confidence intervals (CIs) were calculated to compare the nature of injuries between occupational and non-occupational events overall and by job group.

Results: Of the 6046 injuries (0.72% of events in this age group) that occurred during work, 63.9% were among males. Youth in food and beverage occupations (54.6% males) made up 35.4% of work-related ED visits and 10.2% of work-related hospital admissions, while primary industry workers (76.4% males) made up 4.8% of work-related ED visits and 24.6% of work-related hospital admissions. PIRs were significantly elevated for burns (9.77, 95% CI: 8.94–10.67), crushing/amputations (6.72, 95% CI: 5.79–7.80), electrical injuries (6.04, 95% CI: 3.64–10.00), bites (5.09, 95% CI: 4.47–5.79), open wounds (2.68, 95% CI: 2.59–2.78) and eye injuries (2.50, 95% CI: 2.20–2.83) in occupational versus non-occupational events. These were largely driven by high proportional incidence of injury types unique to job groups.

Conclusion: Our findings provide occupation group-specific information on common injury types that can be used to support targeted approaches to reduce incidence of youth injury in the workplace.

Keywords: adolescent, injury surveillance, occupational injuries, young workers, youth injuries

Highlights

- Information about injuries of children who come to the emergency departments of 11 pediatric hospitals and of 6 general hospitals across the country is recorded in the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP).
- We used CHIRPP data from 1991–2012 to find out how 10- to 17-year-old working youth were injured on the job.
- Youth who work in the food/beverage industry make up the majority of those with work injuries who come to hospital emergency departments.
- Hospital admissions due to work injuries are mainly among youth who work in trades (construction/repair, machinist/metal working/electrical and general labourers), manufacturing and primary industry.
- Young food/beverage and construction workers experienced a significantly greater proportional incidence of burns; delivery and childcare workers present more often for bites; and eye and crushing/amputation injuries were most common in young trades workers, material handlers/vehicle operators and primary industry workers.
- Compared to non-work injuries, incidence of several injury types, notably bites and burns, varied by age within young workers.

Introduction

Many youth get jobs for the intrinsic and material benefits—to acquire skills and earn money.[1] In 2014, nearly half of 15 to 19 year olds, or about 840 000 Canadians, were in the workforce.[2] However, the risk of injury among people in this age group often counters the benefits of working. Between 2011 and 2013, Canadian workers' compensation (WC) boards recorded 20 fatalities among 15- to 19-year-old workers;[3] 23 996 time-loss injury claims were accepted in this age group alone.[4] Although occupational injury data for workers younger than 15 are sparse, surveys of American and Canadian middle-schoolers

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found that 18% of working 10- to 14 year olds reported work injuries from summer jobs[5] and 49.7% of wage-earning 12- to 14 year olds reported work injuries in the past year.[6]

Impairments resulting from injuries that occur early in the work life can impact future work abilities and have long-term health effects.[7] Young people with work injuries have more annual general practitioner visits compared to those without work injuries.[8] Across occupational categories, youth employed in the manual and goods-producing sector have a greater risk of sustaining injuries that result in work disability absence or increased lost-time WC claims compared to those in the service sector.[7,9]

Although claims data are informative, they do not include the injuries of young workers who are not covered by or are ineligible for WC. Since youth are more likely to engage in temporary, casual, contract or seasonal work than adults[10] and the youngest workers frequently work in informal or self-employment arrangements such as farm work, babysitting or with family businesses[5] that are not compulsorily or reliably covered in all provinces,[11] claims data may underestimate youth injuries. This is compounded by general underreporting of work-related injuries by young employees because they fear reprisals, feel powerless or think their employer disregards concerns or because they are not aware of the reporting channels.[12-14]

A 2005 paper described the frequency and distribution of occupational injuries among youth using data collected from the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP).[15] The emergency department (ED) surveillance sites engaged in this system capture a larger portion of the "base" of the injury pyramid by including events not severe enough to result in hospitalization, irrespective of WC coverage or claim submission status. Moreover, data from CHIRPP provide a rich source of information on clinical characteristics and a detailed narrative describing the circumstances surrounding the injury event.

In the 10 years since the original paper's publication, this updated analysis benefits from an increase in statistical power from the greater number of cases captured over time, and includes comparative analyses of injury characteristics between occupational and non-occupational injuries.

Given the substantial burden posed by occupational injuries in this population, identifying injury characteristics and risk factors unique to youth has implications for improving the health of the current and future workforce, as well as preventing prolonged health care use relating to work injuries. Using 22 years of data from CHIRPP, we describe demographic and job-related features of youth occupational injuries, including comparisons to non-occupational injuries and between occupational groups.

Methods

Data source

CHIRPP, an ED-based injury surveillance system under the custodianship of the Public Health Agency of Canada, was initiated in 1990. Participating sites across Canada collect details on injuries and poisonings from the EDs of 11 pediatric and 6 general hospitals. This information is recorded on a CHIRPP reporting form that consists of one page completed by the patient (or on behalf of the patient) describing the circumstances of the injury and a second page completed by the physician noting clinical features of the injury. Forms are centrally coded by trained personnel within the Public Health Agency of Canada. Since 2010, report form entry transitioned to electronic CHIRPP (eCHIRPP) record capture; forms are entered directly by site coordinators to a central web-based application.

Data collected by CHIRPP have been previously described and evaluated as being of good quality when used carefully for public health research purposes.[16]

Study population

Youth aged 10 to 17 years, inclusive, who had completed a CHIRPP form between January 1, 1991, and December 31, 2012, were eligible for inclusion in our analysis. Age was restricted to less than 18 years as this is the typical age below which statutory restrictions on employment in Canada apply.[6] The lower boundary of 10 years was set to capture youth reporting more informal work arrangements.[5] Records with missing date of birth (n = 14) were ineligible for the initial data extraction.

Occupational injury classification

Occupational injuries were identified based on self-report, through a yes/no question in the paper and eCHIRPP form, that the participant was "working for pay" at the time of injury. Since CHIRPP paper-based forms completed before 2011 asked about the context in which the injury occurred, records where the context was coded as "on duty at work" were also extracted as work injuries. Narratives describing injury events as reported by the participant were reviewed, and the job performed at the time of injury was coded into one of 11 categories corresponding to the National Occupational Classification for Statistics 2006 codes based on skill level and tasks performed (http://www.statcan.gc.ca/eng/subjects/standard/soc/2006/noc2006-menu).[17] If the occupation could not be ascertained from the narrative alone (e.g. accidentally cut at work), the place where the injury occurred was used to determine the occupation (e.g. restaurant kitchen).

Occupations in the military are highly varied and can be classified in a manner similar to civilian occupations;[17] however, because of the uniform organizational environment of these injuries, they were included as a separate group denoting jobs in the military as a whole.

Injury characteristics

The "most severe" nature of injury (NOI), as designated by the attending clinician, was used to define the injury characteristics. Due to the small frequencies of some types of injuries, these were further collapsed based on a matrix considering similarity between injury types/affected body parts and potential for misclassification.[18] Musculoskeletal injuries included sprains/strains, injuries to muscle or tendon, not-otherwise-specified soft tissue injuries, and pulled elbows.[19]

Statistical analysis

We calculated descriptive frequency distributions for categorical and means/standard

deviations (SDs) for continuous demographic and injury characteristics by occupational injury status, job group and hospital admission status. Proportionate injury ratios (PIRs) were calculated to compare the relative occurrence of NOIs between occupationally and non-occupationally injured youth overall, by job group, and by age category.[20] The PIR is a ratio of the observed age- and sex-specific cases (1-year age groups for the overall and age category calculations; < 15 years and ≥ 15 years for the job group calculations) in the occupationally injured subgroup to the expected cases based on incidence in the non-occupationally injured group. The PIR was calculated for each collapsed NOI category with 95% confidence intervals (CIs) to determine statistical significance.[21] A PIR greater than 1 indicates that the observed NOI in the occupationally injured subgroup is more common than the expected, based on the NOI occurring in the non-occupationally injured referent group. The PIR has been used in previous injury studies[22-24] and is a useful measure for assessing injury event frequency when population denominator information is unavailable.[25]

All statistical analyses were completed using SAS software version 9.4 for Windows[26] and Microsoft Excel 2010.

Results

We initially extracted a total of 835 888 records of injuries in 10 to 17 year olds from 1991–2012 from the paper-based and eCHIRPP forms. We excluded 167 records that did not record the injured youth's sex. Of 5983 records coded as "work" injuries and 102 records indicating the injury occurred while "on duty at work" (from "context" variable, "work" coded as 0, pre-2011), 7 records were removed because they were probably record duplicates of a unique injury event. A further 32 were recoded as non-work as the narrative conclusively indicated the injury occurred neither at work nor in a work-like environment (e.g. "...Injured while taking acting lessons in a school drama class"). The dichotomous "work" question on the CHIRPP form was affirmatively marked in 14 records, although the narratives noted the youth were volunteering. However, we kept these as work injuries in the analyses because of the diversity of the informal jobs youth do that may not entitle them to payment, yet are similar to paid jobs in terms of tasks, environments and exposure to risk.[5,6]

The final study population consisted of 6046 work injuries and 829 668 non-work-related injuries. As very few (n = 143, < 0.02%) injuries resulting in fatality following ED presentation were captured in our data, and none were work injuries, we retained them in the analysis as part of the non-work-related injuries used to generate the standard proportions.

Table 1 shows sex-stratified characteristics of injuries by occupational status. Males made up the majority of both work and non-work injuries (63.9% vs. 61.7%), and youth injured on the job were, on average, approximately 2.5 years older than non-work-injured youth. Notably, 17-year-old males made up a quarter of youth with work injuries and youth under 12 made up less than 3% (n = 173). The five most common NOIs (open wounds, musculoskeletal injuries, superficial wounds, fractures, and burns) made up 83% of total work injury events. Youth who presented with non-occupational injuries were more frequently admitted to hospital than were those who reported work injuries (5.4% vs. 2.8%), and males were more frequently admitted to hospital in both groups. Males and females experienced different types of injuries; 36.5% of work-injured males experienced open wounds compared to 24.9% of females, and 28.1% of work-injured females presented with musculoskeletal injuries compared to 19.0% of males. Similar patterns in injuries by sex were observed for work and non-work injuries, though to differing magnitudes.

Table 2 shows sex and age group distributions of work-related injuries and hospital admissions by job group. Of the ED visits due to work injuries, 35.4% (n = 2141) were youth in food and beverage jobs (54.6% males, n = 1168). Males made up the greater percentage of injuries among those who work in trades (construction/repair, machinist/metal working/electrical and general labourers), as material handlers/vehicle operators and in the primary industry (logging/forestry, mining, fishing, and agricultural-related) job groups, while work injuries in females were concentrated in those in service and recreation support jobs. The relative contribution of each job group to ED visits and subsequent hospital admission varied substantially; the injured youth in the job group with the largest proportion of work-related ED visits (food and beverage workers) made up only 10.2% of work-related hospital admissions, whereas primary industry workers (76.4% males) made up 4.8% of work-related ED visits and 24.6% of work-related hospital admissions.

We also observed differences by age groups (< 15 years vs. 15 years and older) in the job groups (Table 2). Older youth experienced the majority of ED visits for work-related injuries in most groups. However, 10- to 14-year-old childcare/personal support workers and primary industry workers made up a relatively high proportion of visits to CHIRPP EDs for those job groups (40.4% and 30.2%, respectively). The delivery job group was the only category in which the majority were the youngest workers (75.5% were aged < 15 years).

Compared to non-occupational injuries, we observed significantly elevated PIRs in occupational injuries for open wounds (PIR = 2.68, 95% CI: 2.59–2.78), burns (9.77, 95% CI: 8.94–10.67), eye injuries (2.50, 95% CI: 2.20–2.83), bites (5.09, 95% CI: 4.47–5.79), crushing injuries and amputations (6.72, 95% CI: 5.79–7.80) and electrical injuries (6.04, 95% CI: 3.64–10.00) (Table 3). While most age-stratified PIRs did not appear to differ significantly (i.e. the CIs did not overlap), older adolescents exhibited a higher PIR for burns compared to youth aged 10 to 14 years (PIR = 10.53, 95% CI: 9.62–11.53 vs PIR = 4.38, 95% CI: 2.98–6.43) and youth aged 10 to 14 years had a higher PIR for bites in comparison to that of older youth (PIR = 18.48, 95% CI: 15.75–21.69 vs PIR = 2.20, 95% CI: 1.74–2.78) (Table 3).

By job group, food and beverage workers (PIR = 24.36, 95% CI: 22.28–26.62) and trades/manufacturing workers experienced burns at a higher incidence than did non-occupationally injured youth. Similarly, delivery workers (PIR = 36.97, 95% CI:

TABLE 1
Characteristics of CHIRPP youth injury events by occupational and non-occupational status, 1991–2012

Characteristics	Work injury			Non-work injury		
	All	Males	Females	All	Males	Females
Total, n (%)	6046 (0.72)	3861 (63.9)	2185 (36.1)	829 668 (99.28)	511 662 (61.7)	318 006 (38.3)
Age in years, mean (SD)	15.8 (1.5)	15.7 (1.5)	15.8 (1.5)	13.1 (2.1)	13.1 (2.1)	13.0 (2.1)
NOI, n (%)						
Open wounds	1951 (32.3)	1408 (36.5)	543 (24.9)	90 629 (10.9)	64 861 (12.7)	25 768 (8.1)
Musculoskeletal injuries	1348 (22.3)	734 (19.0)	614 (28.1)	244 674 (29.5)	133 858 (26.2)	110 816 (34.8)
Superficial, including minor cuts and abrasions	731 (12.1)	441 (11.4)	290 (13.3)	126 507 (15.2)	74 427 (14.5)	52 080 (16.4)
Fractures/ dislocations	538 (8.9)	350 (9.1)	188 (8.6)	225 707 (27.2)	153 128 (29.9)	72 579 (22.8)
Burn/corrosion	448 (7.4)	223 (5.8)	225 (10.3)	5469 (0.7)	3064 (0.6)	2405 (0.8)
Eye injuries	225 (3.7)	169 (4.4)	56 (2.6)	12 504 (1.5)	8537 (1.7)	3967 (1.2)
Head injuries	201 (3.3)	112 (2.9)	89 (4.1)	58 856 (7.1)	39 577 (7.7)	19 279 (6.1)
Bite	194 (3.2)	133 (3.4)	61 (2.8)	6438 (0.8)	3631 (0.7)	2807 (0.9)
Crushing/ amputation	164 (2.7)	129 (3.3)	35 (1.6)	3892 (0.5)	2290 (0.4)	1602 (0.5)
Foreign body, excluding eye	42 (0.7)	31 (0.8)	11 (0.5)	8082 (1)	4648 (0.9)	3434 (1.1)
Poisoning	34 (0.6)	26 (0.7)	8 (0.4)	19 301 (2.3)	6177 (1.2)	13 124 (4.1)
Multiple/dental/ other	24 (0.4)	17 (0.4)	7 (0.3)	9063 (1.1)	6472 (1.3)	2591 (0.8)
Electrical injury	15 (0.2)	9 (0.2)	6 (0.3)	327 (0)	183 (0.0)	144 (0.0)
Frostbite/heat or cold stress/ systemic over-exertion	11 (0.2)	[a]	[a]	755 (0.1)	494 (0.1)	261 (0.1)
Drowning/ immersion or asphyxia	9 (0.1)	[a]	[a]	904 (0.1)	512 (0.1)	392 (0.1)
Missing, not specified or not detected	111 (1.8)	64 (1.7)	47 (2.2)	16 560 (2)	9803 (1.9)	6757 (2.1)
Admitted to hospital, n (%)	170 (2.8)	138 (3.6)	32 (1.5)	44 902 (5.4)	29 382 (5.7)	15 520 (4.9)

Abbreviations: CHIRPP, Canadian Hospitals Injury Reporting and Prevention Program; NOI, nature of injury.

[a] Value suppressed, < 5 observations in one or both sexes.

32.23–42.41) and childcare/personal support workers (PIR = 29.27, 95% CI: 21.08–40.63) had a higher than expected incidence of bites (Table 4). Crushing/amputation injuries had consistently elevated PIRs across all manual/goods producing job groups, particularly in other trades/manufacturing workers (PIR = 22.68, 95% CI: 15.34–33.54). This group, which includes metalworkers such as welders, also had the highest proportional incidence of eye injuries (PIR = 13.01, 95% CI: 10.11–16.74). While head injuries did not occur more than expected among all pooled work injuries, youth working in arts/recreation/entertainment jobs experienced a significantly greater incidence of head injuries relative to youth with non-work injuries (PIR = 1.34, 95% CI: 1.01–1.77) (Table 4).

Table 5 shows the most common injuries within each job group. Crushing/amputation injuries were seen in less than 3% of work-related youth presentations to CHIRPP EDs, but were more common among primary industry and material handlers/vehicle operators, and represented almost one-fifth of work-related hospital admissions (n = 29, 17.1%; data not shown). Musculoskeletal injuries were common among young service sector workers and material handlers, although they did not occur more commonly in work injuries relative to non-work injuries as reflected in the PIRs. Other injuries, such as open wounds and burns in food/beverage workers, and bites in delivery workers, were both common and were significantly elevated among youth with work injuries in comparison to youth with non-occupational injuries.

Discussion

Consistent with previous literature, our study found that youth who reported work-related injuries in EDs were predominantly male, a reflection of characteristic job type distributions by sex. Most injuries occurred while working in service sector jobs, particularly food and beverage service occupations, although the injuries that occurred while working in trades, manufacturing and primary industry more often resulted in hospital admission. We also demonstrated that, aside from experiencing an elevated proportional incidence of burns, crushing/amputations, bites, electrical injuries, eye injuries and open wounds overall, youth had significantly higher proportional incidences of specific injury types unique to each occupational group and age category.

A study that examined work injuries across age groups found adolescents had a rate of permanent impairment as a result of amputations, burns and cuts higher than that of adults.[7] This pattern was reflected in our data, in which open wounds (which included more severe cuts), burns and crushing injuries/amputations made up almost half of work injuries. Similarly, recent findings from an American study analyzing ED records showed that workers aged 15 to 19 years experienced burns at more than double older workers' rate.[27] As in our study, burns were highest among workers in accommodation and food services, agriculture, manufacturing and construction.

TABLE 2
Characteristics of CHIRPP youth injury events by occupational group, 1991–2012

Characteristic	Occupational group												
	Food/ Beverage	Other service sector	Delivery	Arts/ Recreation/ Entertainment	Construction trades	Retail/ Administration	Primary Industry	Material handlers/ vehicle operators	Other trades/ Manufacturing	Childcare/ Personal support	Military	Unable to determine	Total
Age group, n (%)													
10–14	106 (5.0)	44 (6.8)	383 (75.5)	91 (19.4)	44 (10.8)	19 (5.1)	87 (30.2)	17 (6.4)	15 (6.2)	46 (40.4)	14 (25.0)	64 (11.7)	930 (15.4)
15–17	2035 (95.1)	600 (93.2)	124 (24.5)	377 (80.6)	363 (89.2)	351 (94.9)	201 (69.8)	247 (93.6)	227 (93.8)	68 (59.7)	42 (75.0)	481 (88.3)	5116 (84.6)
Male, %	54.6	74.7	70.2	50.4	94.1	43.2	76.4	91.7	90.9	22.8	60.7	61.5	63.9
Proportion of total work-related ED visits, %	35.4	10.7	8.4	7.7	6.7	6.1	4.8	4.4	4.0	1.9	0.9	9.0	100.0
Proportion of work-related hospitalization, %	10.2	3.0	6.6	7.2	21.0	3.0	24.6	6.0	12.6	[a]	[a]	6.0	100.0

Abbreviations: CHIRPP, Canadian Hospitals Injury Reporting and Prevention Program; ED, emergency department.

Note: Other trades/manufacturing: NOC codes H2, H3, H22, and J[17] (see http://www.statcan.gc.ca/eng/subjects/standard/soc/2006/noc2006-menu).

[a] Value suppressed, < 5 observations.

We observed a particularly high PIR for burns in older adolescent food and beverage workers; given that only 26.1% of teen workers exposed to burn hazards report using burn protection (e.g. oven mitts),[28] strategies to reduce barriers to protective equipment use may be valuable in reducing a primary cause of injury in young people in these common occupations.

Eye and crushing/amputation injuries were almost universally higher in all job groups relative to non-work events, particularly in the trades, manufacturing and primary industry jobs. Previous studies that observed eye injuries in adult construction workers attributed this in part to inadequate eyewear.[29] We did not investigate the use of personal protective equipment in our study; however, younger workers may perceive lower risks of eye injury and be less likely to use eye protection.[30] Of note, given the increased potential for permanent impairment,[7] the elevated PIRs and high frequency of hospitalization for crushing/amputation injuries emphasizes the importance of identifying effective protection measures for youth working with hazards. Our observation that the PIR for this injury type in youth aged 10 to 14 years was on par with that in older adolescents indicates that the youngest workers in some work environments may be exposed to conditions, equipment or tasks that do not reflect their skill level.

The low PIRs of musculoskeletal injuries may reflect lower rates of repetitive strain injuries in younger workers compared to older ones.[31] Despite their low relative incidence, these were still common work-related injuries in youth in our study, particularly among females. Given the potential for persistent or prolonged health care use[8] plus the increase in work-related musculoskeletal injuries that occurs with age, our findings support recommendations to prioritize injury prevention efforts early in the work life.[7]

Of note, we observed a higher PIR for head injuries among young arts/recreation/entertainment workers that was not evident in the pooled PIRs. These workers were primarily camp counsellors, lifeguards and other recreational leaders/instructors. This

TABLE 3
Age- and sex-adjusted proportional injury ratios of the nature of youth occupational injuries compared to non-occupational injuries, by age group, 1991–2012

Nature of injury	Age group					
	All ages (10–17 years)		15–17 years		10–14 years	
	N	PIR (95% CI)	N	PIR (95% CI)	N	PIR (95% CI)
Open wound	1951	**2.68 (2.59–2.78)**	1741	**2.76 (2.65–2.86)**	210	**2.20 (1.96–2.47)**
Musculoskeletal injury	1348	0.69 (0.66–0.72)	1169	0.70 (0.66–0.73)	179	0.66 (0.58–0.75)
Superficial–including minor cuts and abrasions	731	0.84 (0.79–0.9)	593	0.81 (0.75–0.88)	138	0.99 (0.85–1.15)
Fracture/dislocation	538	0.40 (0.37–0.44)	395	0.37 (0.34–0.41)	143	0.53 (0.46–0.62)
Burn/corrosion	448	**9.77 (8.94–10.67)**	423	**10.53 (9.62–11.53)**	25	**4.38 (2.98–6.43)**
Eye injury	225	**2.50 (2.2–2.83)**	205	**2.67 (2.34–3.05)**	20	1.49 (0.97–2.29)
Head injury	201	0.47 (0.41–0.54)	161	0.45 (0.38–0.52)	40	0.61 (0.45–0.82)
Bite	194	**5.09 (4.47–5.79)**	69	**2.20 (1.74–2.78)**	125	**18.48 (15.75–21.69)**
Crushing/amputation	164	**6.72 (5.79–7.8)**	136	**6.78 (5.74–8.00)**	28	**6.44 (4.48–9.25)**
Foreign body, excluding in the eye	42	0.83 (0.61–1.12)	38	0.9 (0.66–1.24)	[a]	—
Poisoning	34	0.13 (0.09–0.18)	32	0.13 (0.09–0.19)	[a]	—
Multiple/dental/other	24	0.32 (0.21–0.48)	22	0.34 (0.22–0.51)	[a]	—
Electrical injury	15	**6.04 (3.64–10.00)**	13	**6.04 (3.51–10.39)**	[a]	—
Frostbite/heat or cold stress/systemic over-exertion	11	1.42 (0.79–2.57)	11	1.61 (0.89–2.9)	0	—
Drowning/immersion or asphyxia	9	1.14 (0.59–2.18)	8	1.16 (0.58–2.33)	[a]	—
Missing, not specified, or not detected	111	0.80 (0.67–0.96)	100	0.83 (0.68–1.00)	11	0.63 (0.35–1.13)
Total	6046		5116		930[b]	

Abbreviations: CI, confidence interval; NOI, nature of injury; PIR, proportional injury ratios.

Note: Bolded values indicates significantly elevated PIRs, lower 95% CI bound > 1.

[a] PIR not shown for NOI where N < 5.

[b] Total includes NOI categories where N < 5.

injury burden may reflect their contextual similarity to sports injuries, which typically represent a large proportion of head injuries in youth.[32] As even mild traumatic brain injuries at younger ages have been associated with lower education attainment and employment status,[33] the consequences of these injuries can be long-lasting.

The heterogeneity of the injuries across jobs raises the question of best ways to protect young workers. A survey of working 14- to 18-year-old Ontarians reported that although over 90% received safety training, 38% were unsupervised for at least part of the workday.[11] While we were unable to assess supervision status in our study, youth working as recreational instructors or childcare providers (e.g. babysitters) or in delivery are often supervisors themselves or work alone. Our observation of significantly elevated PIRs for head injuries (arts/recreation workers) and bites (childcare and delivery workers) in these groups may reflect the inherent lack of supervision. This is salient in light of the younger age of many of these workers. In such cases, it may be more feasible to emphasize the use of any safety equipment or to strengthen training before job commencement.

Strengths and limitations

Our analysis was strengthened by expanding beyond basic descriptive analysis with the application of age- and sex-adjusted PIRs, with which we were able to statistically assess differences in NOI incidence between work injury subgroups and a non-work-injury reference population. The PIRs calculated are in comparison to non-occupational injuries, and are therefore dependent on the distribution of injuries in this referent population and are not interpretable as rates. However, they are nevertheless informative in that this may provide clues into underlying mechanisms of observed injury patterns. Using head injuries as an example, the mostly depressed PIRs suggest that, in addition to head injuries being more common in non-occupational injuries, it is possible that measures to prevent head injuries in young workers in some jobs, e.g. requiring hard hat use on work sites, may be conferring a protective effect. Comparing incidence of work injuries in relation to non-work injuries using the PIR allows us to consider contextual factors unique to occupational environments that may result in different injury patterns or types.

We applied a nationally standardized occupational classification system (NOC-S) to our data to present a more nuanced depiction of the jobs youth were performing when they were injured. Using this scheme allows comparison to national statistics collected from data sources such as the Labour Force Survey.[34] The strong consistency between our results and those published in the literature also indicates that youth job data from CHIRPP records coded using the NOC-S guidelines are comparable

TABLE 4

Age- and sex-adjusted proportional injury ratios of the nature of youth occupational injuries by job group compared to non-occupational injuries, by occupational group, 1991–2012

Nature of injury	Food and beverage n = 2141		Other service sector n = 644		Unable to determine n = 545		Delivery n = 507		Arts/Recreation/Entertainment n = 468		Construction trades n = 407	
	PIR	95% CI	PIR	95% CI	PIR	95% CI	PIR	95% CI	PIR	95% CI	PIR	95% CI
Missing, NS or ND	0.98	0.74–1.31	1.19	0.74–1.93	0.77	0.40–1.48	[a]	—	0.99	0.53–1.82	0.99	0.50–1.96
Open wounds	**4.35**	**4.17–4.55**	**2.73**	**2.45–3.05**	**2.10**	**1.81–2.43**	0.86	0.66–1.12	1.22	0.96–1.53	3.01	2.67–3.40
Superficial	0.54	0.47–0.62	0.80	0.65–0.99	1.04	0.85–1.27	1.07	0.88–1.30	1.00	0.80–1.24	0.73	0.55–0.97
Musculoskeletal injuries	0.38	0.34–0.43	1.02	0.91–1.14	1.02	0.91–1.15	0.92	0.80–1.07	1.05	0.93–1.19	0.54	0.43–0.67
Fractures/dislocations	0.15	0.12–0.19	0.26	0.19–0.35	0.48	0.38–0.61	0.50	0.40–0.62	0.83	0.69–1.01	0.38	0.29–0.51
Burn/Corrosion	**24.36**	**22.28–26.62**	**4.06**	**2.58–6.39**	**2.28**	**1.19–4.35**	[a]	—	1.42	0.60–3.38	**4.33**	**2.43–7.72**
Bite	NS	—	**2.48**	**1.30–4.70**	1.79	0.81–3.93	**36.97**	**32.23–42.41**	NS	—	NS	—
Eye injuries	**1.88**	**1.46–2.43**	**2.61**	**1.78–3.83**	**1.76**	**1.06–2.93**	[a]	—	**1.78**	**1.02–3.11**	**6.23**	**4.63–8.39**
Head injuries	0.23	0.17–0.32	0.36	0.23–0.58	0.79	0.56–1.10	0.49	0.31–0.77	**1.34**	**1.01–1.77**	0.27	0.14–0.53
Crushing/amputation	**5.01**	**3.74–6.71**	**4.59**	**2.62–8.03**	**6.64**	**4.04–10.92**	[a]	—	**2.52**	**1.06–5.99**	**14.61**	**9.93–21.49**
Poisoning	0.10	0.06–0.18	0.32	0.16–0.63	0.20	0.09–0.49	NS	—	NS	—	[a]	—
Electrical injury	**5.75**	**2.40–13.78**	[a]	—	NS	—	NS	—	NS	—	[a]	—
Drowning/immersion or asphyxia	NS	—	NS	—	[a]	—	NS	—	NS	—	NS	—
Frostbite/heat or cold stress/systemic over-exertion	NS	—	[a]	—	NS	—	NS	—	NS	—	NS	—
Foreign body, excluding eye	0.45	0.22–0.9	1.19	0.54–2.63	NS	—	NS	—	NS	—	**2.98**	**1.56–5.68**
Multiple/dental/other	0.24	0.11–0.53	NS	—	NS	—	NS	—	NS	—	NS	—

Nature of injury	Retail/Administrative n = 370		Primary industry/ Agriculture/Landscape n = 288		Material handlers/ Vehicle operators n = 264		Other trades/ Manufacturing n = 242		Childcare/Other personal support n = 114		Military[c] n = 56	
	PIR	95% CI	PIR	95% CI	PIR	95% CI	PIR	95% CI	PIR	95% CI	PIR	95% CI
Missing, NS or ND	0.84	0.41–1.75	[b]	—	[b]	—	[b]	—	[b]	—	[a]	—
Open wounds	**2.84**	**2.44–3.30**	**1.96**	**1.60–2.41**	**1.55**	**1.23–1.95**	**2.18**	**1.78–2.67**	**1.60**	**1.04–2.46**	1.12	0.58–2.16
Superficial	1.01	0.79–1.28	1.13	0.87–1.47	**1.56**	**1.24–1.97**	0.84	0.60–1.18	1.13	0.76–1.67	1.10	0.60–1.99
Musculoskeletal injuries	1.00	0.87–1.15	0.59	0.46–0.75	1.14	0.97–1.34	0.47	0.35–0.64	0.49	0.33–0.74	**1.25**	**0.91–1.71**
Fractures/dislocations	0.40	0.28–0.56	0.77	0.61–0.97	0.50	0.36–0.68	0.37	0.25–0.54	0.69	0.45–1.06	0.60	0.32–1.12
Burn/Corrosion	[b]	—	[b]	—	[a]	—	**3.24**	**1.38–7.63**	[b]	—	[a]	—
Bite	[b]	—	[b]	—	[a]	—	[a]	[a]	**29.27**	**21.08–40.63**	[a]	—
Eye injuries	1.34	0.64–2.78	**3.20**	**1.93–5.32**	[a]	—	**13.01**	**10.11–16.74**	[b]	—	[b]	—
Head injuries	0.67	0.43–1.05	0.48	0.26–0.87	0.31	0.14–0.69	0.34	0.15–0.75	[b]	—	[b]	—
Crushing/amputation	[b]	—	**18.76**	**12.74–27.64**	**12.28**	**7.24–20.82**	**22.68**	**15.34–33.54**	[b]	—	[a]	—
Poisoning	[b]	—	[b]	—	[b]	—	[b]	—	[b]	—	[a]	—
Electrical injury	[b]	—	[b]	—	[a]	—	[b]	—	[a]	—	[a]	[a]
Drowning/immersion or asphyxia	[b]	—	[a]	—	[a]	—	[a]	—	[b]	—	[a]	[a]
Frostbite/heat or cold stress/systemic over-exertion	[a]	—	[b]	—	[b]	—	[a]	—	[a]	—	[b]	—
Foreign body, excluding eye	1.56	0.66–3.73	[b]	—	[b]	—	[b]	—	[b]	—	[b]	—
Multiple/dental/other	[b]	—	[b]	—	[b]	—	[b]	—	[b]	—	[a]	—

Abbreviations: CI, confidence interval; ND, not determined; NS, not specified; PIR, proportional injury ratios.

Notes: Other trades/manufacturing: NOC codes H2, H3, H22, and J[17](See http://www.statcan.gc.ca/eng/subjects/standard/soc/2006/noc2006-menu).

PIRs with a lower confidence limit greater than 0 are bolded.

[a]PIRs not calculated due to aggregate cell size of 0 for that NOI within job group.

[b]PIR calculation suppressed due to NOI-specific aggregate cell size <5 within job group.

[c]Age restrictions to join the military are minimum 16–18 years old, depending on enrolment terms.

TABLE 5
Five most common natures of injury by occupational domain

Occupational group	NOI in order of decreasing occurrence									
	1st		2nd		3rd		4th		5th	
	NOI	N (%)	NOI	N (%)	NOI	N (%)	NOI	N (%)	NOI	N (%)
Food/Beverage n = 2141	Open wounds	1025 (47.9)	Burn/corrosion	394 (18.4)	MSK injuries	266 (12.4)	Superficial	168 (7.8)	Fractures/dislocations	70 (3.3)
Other service sector n = 644	Open wounds	210 (32.6)	MSK injuries	205 (31.8)	Superficial	73 (11.3)	Fractures/dislocations	40 (6.2)	Eye injuries	25 (3.9)
Unable to determine n = 545	MSK injuries	178 (32.7)	Open wounds	129 (23.7)	Superficial	82 (15.0)	Fractures/dislocations	60 (11.0)	Head injuries	31 (5.7)
Delivery n = 507	Bites	144 (28.4)	MSK injuries	134 (26.4)	Superficial	82 (16.2)	Fractures/dislocations	71 (14.0)	Open wounds	49 (9.7)
Arts/Recreation/Entertainment n = 468	MSK injuries	160 (34.2)	Fractures/ dislocations	87 (18.6)	Superficial	69 (14.7)	Open wounds	61 (13.0)	Head injuries	45 (9.6)
Construction trades n = 407	Open wounds	157 (38.6)	MSK injuries	65 (16.0)	Superficial	41 (10.1)	Fractures/dislocations	41 (10.1)	Eye injuries	39 (9.6)
Retail/Administrative n = 370	MSK injuries	124 (33.5)	Open wounds	110 (29.7)	Superficial	55 (14.9)	Fractures/dislocations	30 (8.1)	Head injuries	18 (4.9)
Primary Industry/Farming/Landscape n = 288	Open wounds	67 (23.3)	Fractures/ dislocations	57 (19.8)	MSK injuries	51 (17.7)	Superficial	47 (16.3)	Crushing/amputation	23 (8.0)
Material Handlers/Vehicle Operators n = 264	MSK injuries	90 (34.1)	Superficial	57 (21.6)	Open wounds	52 (19.7)	Fractures/dislocations	34 (12.9)	Crushing/amputation	13 (4.9)
Other trades/Manufacturing/ Processing n = 242	Open wounds	67 (27.7)	Eye injuries	48 (19.8)	MSK injuries	34 (14.0)	Superficial	28 (11.6)	Fractures/dislocations	23 (9.5)
Childcare/Personal support n = 114	Bites	26 (22.8)	Superficial	20 (17.5)	MSK injuries	19 (16.7)	Fractures/dislocations	17 (14.9)	Open wounds	17 (14.9)
Military n = 56	MSK injuries	22 (39.3)	Superficial	9 (16.1)	Fractures/ dislocations	8 (14.3)	Open wounds	7 (12.5)	Eye injuries & Head injuries	6 (10.7)
All job groups n = 6046	Open wounds	1951 (32.3)	MSK injuries	1348 (22.3)	Superficial	731 (12.1)	Fractures/dislocations	538 (8.9)	Burn/corrosion	448 (7.4)

Abbreviations: MSK, musculoskeletal; NOI, nature of injury.

Note: Other trades/manufacturing: NOC codes H2, H3, H22, and J[17] (see http://www.statcan.gc.ca/eng/subjects/standard/soc/2006/noc2006-menu).

to other studies investigating youth work injuries using different criteria. Although this classification scheme precludes attributing injury incidence to specific jobs, NOC groups classify jobs involving comparable tasks or duties, education requirements and environments together. Therefore, jobs within a group are likely to expose workers to similar types of hazards. A limitation of this method is that there is no standardized algorithm for assigning jobs or tasks.

Our study also has several limitations, which may affect the results. Most CHIRPP EDs are not population-based as they are strategically located sentinel sites for the purpose of active surveillance. Certain groups are underrepresented, including older teens and residents of rural or remote areas; therefore, injury types and job groups unique to these areas and populations may be underestimated in our analysis. Injuries requiring admission are more likely to be missed at CHIRPP sites; our estimates likely understate the frequency of more severe youth injuries.[16] However, injury characteristic data collected from several CHIRPP sites hypothesized to be fully population-representative were shown to be highly correlated with data collected from a national population-based survey. Data from the population-representative CHIRPP sites were also consistent with other CHIRPP sites.[35] This suggests that external validity of CHIRPP injury data may be cautiously inferred to evaluate aggregate national trends in youth injuries.[35] Moreover, a study examining sports injuries among youth reported high validity of injury characteristics captured by a CHIRPP children's hospital when compared to those captured by a local administrative data source.[36] The percent of males aged 10 to 17 years presenting to CHIRPP was similar, though slightly higher than the percent of males with trauma captured by the National Ambulatory Care Reporting System (NACRS) (61.7% vs 59.2%);[37] the slightly older age group reported by NACRS (ages 10–19) may account for this slight difference.

At the time of data extraction, transition from CHIRPP paper records to eCHIRPP was ongoing and data from 2011 and 2012 were not complete for all sites. To assess how sensitive the job group characteristics were to inclusion of eCHIRPP records from incomplete years, the proportion of work-related injuries for each job group was calculated using only the complete, paper-based records for injuries occurring from 1991 to 2010, and then again for the full dataset. It did not appear that the proportions of work injuries by job group were substantially affected by completeness of annual record entry as the percent change between the two calculations was less than 10% (−5.10% to 5.66%) for each group (results not shown). Similarly, analyses using only records for years with complete data entry (1991–2010) produced negligibly different PIRs, with no changes in significance levels (overlapping CIs), compared to analyses using all records up to 2012. For example, the PIRs and 95% CIs for open wounds in 1991 to 2010 and 1991 to 2012 were 2.64 (2.52–2.76) and 2.68 (2.57–2.80), respectively (results not shown).

Although the job codes were based upon a consistent method, the subjectivity of the coder may have resulted in misclassification. Although we did not perform formal validation studies, we did observe expected patterns between and within job groups for sex, age and trends in job availability. For example, ED visits for delivery job work injuries as a percent of all work-related ED visits declined from 13.5% to 4.4% between 1991–1997 and 2005–2012, possibly coinciding with declining hardcopy newspaper circulation. The PIRs for the "Unable to be determined" records were generally reflective of the pooled PIRs, indicating ambiguous records were not clustered in a particular job group or sector, and the PIRs also demonstrated predictable injury characteristics by job group, indicating preliminary validity of our classifications. Given these signals, systematic misclassification of job coding was not evident.

Conclusion

We used a nationally standardized job classification scheme and PIRs to analyze youth occupational injuries captured by the CHIRPP surveillance system. This study adds to the growing body of evidence pointing to a greater incidence of specific injuries associated with job groups and age compared to non-occupational injuries. These findings can be used to support targeted, age-specific prevention measures that can lead to a reduction of injuries.

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